



Commercial Building Initiative

Performance Lighting Specification for Parking Structures

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Presentation Overview

Why parking garages...

- Operating hours
- Lighting large % of energy

Parking Garage Lighting Specification

- Illuminance
- Energy Usage
- Light Source Selection
- Luminaire Requirements

Economics

- EPC Act 2005 tax credit
- Example

Controls

- Daylight Dimming
- Occupancy Sensing

Case Studies

Products

Additional Information



Why...

Operation

Operation

- Long operating hours
 - 24/7 is not atypical
- Operation during peak electricity periods

Energy usage in space:

1. HVAC (only if conditioned space)
2. Lighting
3. Other Misc. Loads
 1. Elevators
 2. Small offices
 3. Heating for attendant booths
 4. Mechanical arms



Parking Structure Lighting Specification



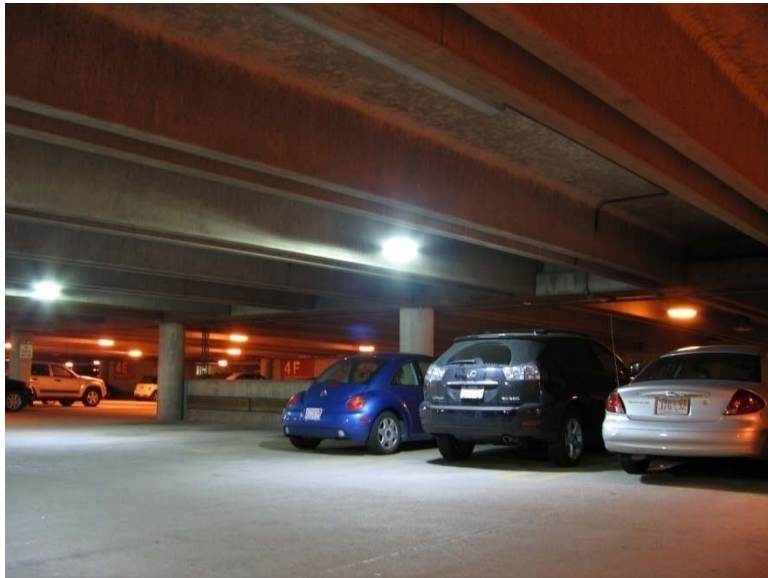
Industry Illuminance Recommendations

IESNA Recommendations

Area	Time of Day	Minimum Horizontal Illuminance (fc)	Uniformity Ratio (max:min)	Minimum Vertical Illuminance (fc)
Basic		1.0	10:1	0.5
Ramps	Day	2.0	10:1	1.0
Ramps	Night	1.0	10:1	0.5
Entrance	Day	50.0	10:1	25.0
Entrance	Night	1.0	10:1	0.5
Stairs		2.0	10:1	0.1

Table from IESNA RP-20-98 *Lighting for Parking Facilities*

Illuminance



Illuminance Requirements

- Maintained minimum horizontal illuminance of 1.25 fc
- Maintained minimum vertical illuminance of 0.5 fc at 5' AFF
- Uniformity:
 - CV of 0.38
 - Equates to avg:min of 4:1
 - Equates to max:min of 7:1

Energy Usage (Power Density)

Specification Requirements

Site/Application Energy Usage

- Std. 90.1-2007 allows LPD: 0.3 W/sf (whole building)
- Std. 90.1-2007 allowed LPD: 0.2 W/sf (space by space)
- *Std. 90.1-2001 allowed LPD: 0.3 W/sf (EPAct)*



Site/Application Energy Usage

- Sets a max LPD: 0.225 W/sf
- Provides target LPD: 0.18 W/sf
 - Complies with EPAct Property Tax Incentive

LPD – Lighting Power Density

- Ratio of rated wattage (W) of installed luminaires compared to the area (sf) where the luminaires are installed

Light Source Selection

Metal Halide

Review of technology

- **NOT part of the specification**
- Metal halides generate light
- Medium CRI
- High efficacy
- Lumen Depreciation 0.75 @ 40% of rated life
- Typical life: 16,000+ hours
- Ballast adds $\approx 10 - 15\%$ to lamp power
- In a significant number of existing installations
- Not functionally dimmable
- Not compatible with occupancy sensors



Light Source Selection

High-Pressure Sodium

Review of technology

- **NOT** part of the specification
- Sodium vapor generate light
- Low CRI
- High efficacy
- Lumen Depreciation 0.85 @ 50% of rated life
- Typical life: 24,000+ hours
- Ballast adds $\approx 10 - 15\%$ to lamp power
- In a significant number of existing installations
- Not functionally dimmable
- Not compatible with occupancy sensors

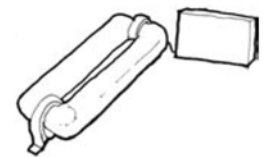


Light Source Selection

Induction

Review of technology

- **NOT** part of the specification
- Uses high-frequency EM-field to stimulate phosphor to generate light
- High CRI
- High efficacy at initially
- Lumen Depreciation 0.75 @ 40% of rated life
- Typical life: 100,000 hours (generator might be less)
- Different light source shape/size limits competitive luminaires
- Dimmable



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Light Source Selection

Fluorescent

Review of technology

- Part of specification
- Mercury stimulates phosphors to generate light
- High CRI
- High efficacy
- Lumen Depreciation 0.92 @ 50% of rated life
- Typical life: 30,000+ hours
- Represents small but upcoming number of installations
- Dimmable
- Easily used with occupancy sensors



Light Source Selection

LED

Review of technology

- Part of specification
- Solid-state technology generates light
- Medium to high CRI
- Medium Efficacy
- Lumen Depreciation: 0.70 end-of-useful life
- Typical life: 50,000+ hours*
- Represents small but upcoming number of installations
- Dimmable – some compatibility issues
- Easily used with occupancy sensors



Light Source Selection

Specification Requirements

Life Requirements:

- Operating life greater than 36,000 hours

Operating Temperature Recommendations:

- Operating temperature range:
 - -40°C to 30°C (LEDs)
 - 20°C to 60°C (fluorescent)

CRI Requirements:

- A minimum CRI of 65

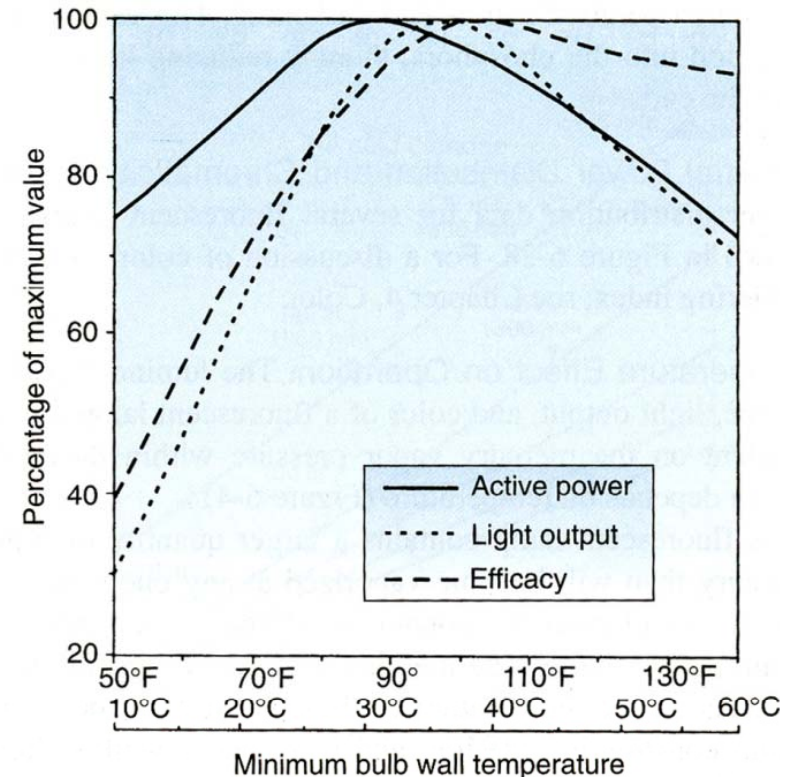


Image from IESNA LIGHTING HANDBOOK 9th Edition

Luminaire Requirements

Source/Luminaire Efficacy



Fluorescent Requirement

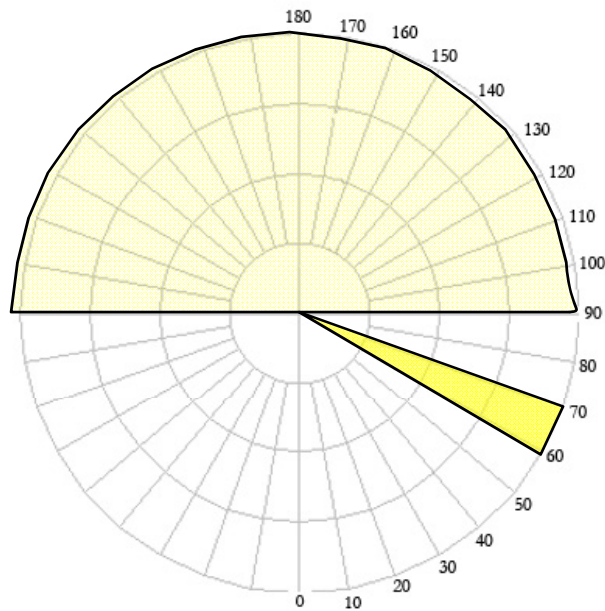
- Mean Lumens per Watt (MLPW) of lamp and ballast: 90 LPW
- Minimum light fixture efficiency: 70%
- Or some combination of the two to be: 63 LPW

LED Requirement

- Luminaire efficacy of 63 LPW at 350 mA

Luminaire Requirements

Zonal Lumen Requirements

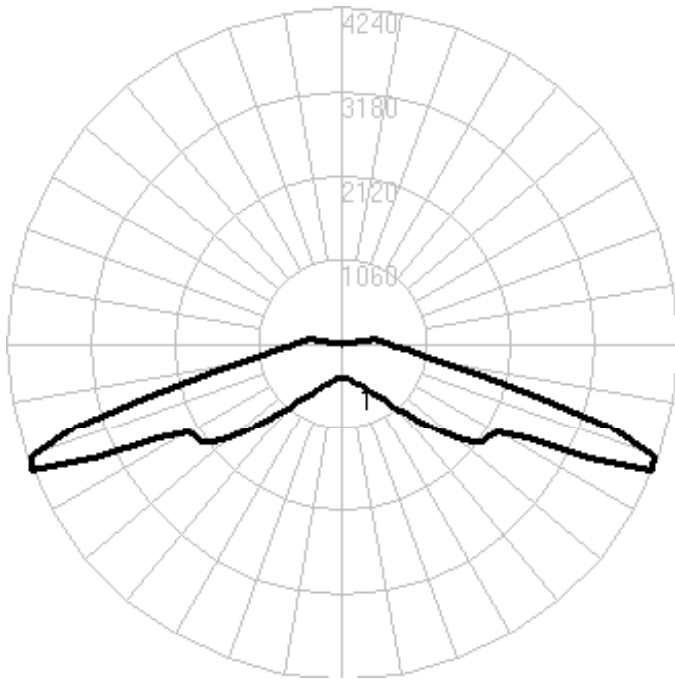


Distribution

- Luminaire with minimum of 20% of zonal lumens in 60° to 70° vertical zones
- Some % above 90°
 - Retailers at Lighting Supplier Summit said that some uplight is desired
 - Makes the space feel a little brighter
 - Can help light adjacent signage

Luminaire Requirements

Example

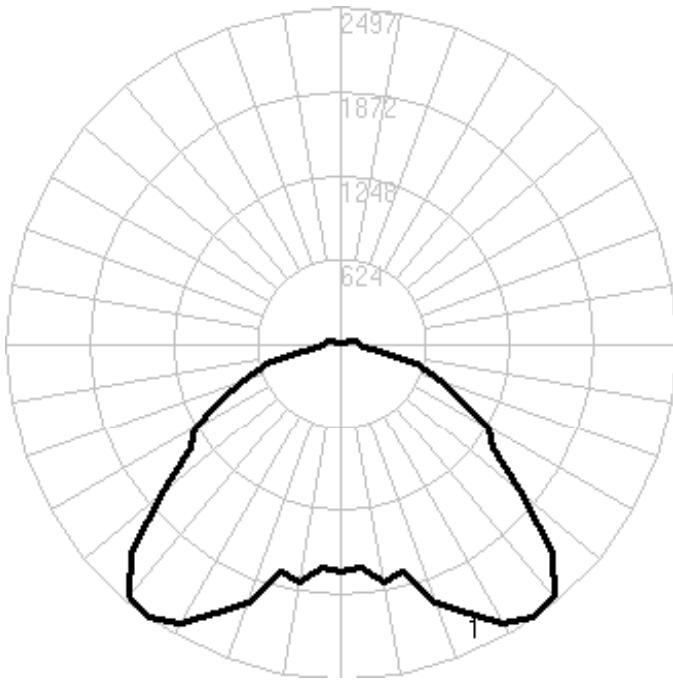


Photometric curve of Widelite VZ38-100-B

Vertical Zone	Lumens	Percent of Total
0-10	39.99	0.53%
10-20	125.19	1.67%
20-30	227.73	3.04%
30-40	376.39	5.02%
40-50	652.58	8.71%
50-60	1133.07	15.12%
60-70	1863.19	24.86%
70-80	1957.86	26.12%
80-90	736.76	9.83%
90-120	376.83	5.03%
120-150	5.06	0.07%
150-180	0.85	0.01%

Luminaire Requirements

Example

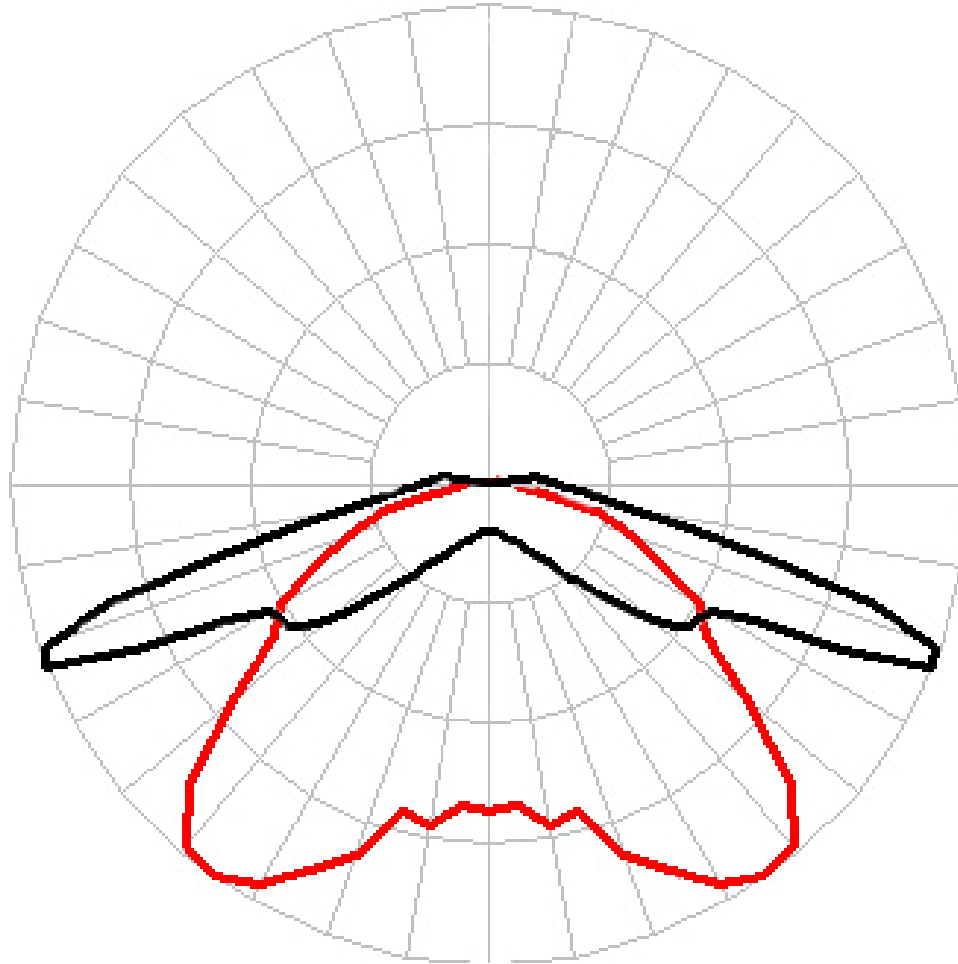


Photometric curve of Widelite VZ38-100-D

Vertical Zone	Lumens	Percent of Total
0-10	165.6	0.21%
10-20	507.84	6.78%
20-30	897.11	11.98%
30-40	1287.69	17.19%
40-50	1483.32	19.80%
50-60	1288.88	17.21%
60-70	955.05	12.75%
70-80	539.04	7.20%
80-90	182.06	2.43%
90-120	174.83	2.33%
120-150	6.45	0.09%
150-180	2.24	0.03%

Luminaire Requirements

Example



Luminaire Requirements

Distribution Continued

Target Efficacy Rating

- NEMA LE6-2008
- Luminaires will have a TER greater than 30 (an EEF value must be at least 0.45)
- EEF – an average of CUs for 30/0/20 for RCR of 2&3

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

Effective Floor Cavity Reflectance 0.20

RC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	119	119	119	119	116	116	116	116	111	111	111	106	106	106	102	102	102	100
1	106	100	95	90	103	98	93	88	93	89	85	89	86	83	85	83	80	78
2	93	83	74	67	90	81	73	66	77	70	64	73	68	63	70	65	61	59
3	82	69	59	50	79	67	58	50	64	56	49	61	54	48	58	52	47	44
4	73	58	47	39	71	57	47	39	54	45	38	52	44	38	49	42	37	34
5	66	50	39	31	63	49	39	31	47	37	30	44	36	30	42	35	30	27
6	60	44	33	25	58	43	33	25	41	32	25	39	31	25	37	30	24	22
7	55	39	28	21	53	38	28	21	36	27	21	34	26	20	33	26	20	18
8	50	35	25	18	49	34	24	18	32	24	18	31	23	17	30	23	17	15
9	47	31	22	15	45	30	21	15	29	21	15	28	20	15	27	20	15	13
10	43	28	19	13	42	28	19	13	27	19	13	26	18	13	25	18	13	11

Coefficient Table of BetaLED BXAL15028A-U

PNNL-SA-66711

Luminaire Requirements

Distribution Continued



Efficient Luminaire

- Utilizes fluorescent technology
- However, source is only one part – distribution is just as important



Wrong Distribution

- Solely indirect
- Low-reflectance ceiling absorbs $\approx 65\%$ of the light

SSL ENERGY STAR – Parking Garage Luminaire

- Initially released for comment in August 2008
 - Minimum Light Output: 4000 lumens
 - Zonal Lumen Density Requirement:
20% in the 60° - 70°
 - Minimum Luminaire Efficacy: 56 lm/W
- Tentative release date for new draft: end of June 2009 for public review¹



Economics

Overview Of 1st Costs

HID

\$250 - 450



Photo from Grainger

FLUORESCENT

\$150 - 275



Photo from Grainger

LED

\$300 - 1200



Photo from Relume

PRICES ARE AN ESTIMATE AND VARY ON A NUMBER OF FACTORS

Financial Incentives for LPDs

- Sliding scale reductions for property taxes
- \$0.30 / sf when lighting is 0.225 W/sf
- \$0.60 / sf when lighting is 0.18 W/sf
- Applicable to covered floors
 - Open-to-sky top floors not applicable
- Extended from expiring in 2009 to December 31, 2013
- IRS Notice 2008-40 issued March 7, 2008
- Gov't Structures \$\$ → Design Team



Parking Structures → Low-hanging fruit

- Large footprint, but low equipment density
 - High property tax rebate with low-capital outlay

Economics

Example

Existing 175W PMH

- Floor Size: 72,896 sq ft
- LPD: 0.25 W/sf
- Yearly kWh: 159,642 (24/7 Operation)
- Electricity Cost: \$13,250.31 (\$0.083/kWh)
- LPD: 0.25 W/sf
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- Electricity Cost: \$13,250.31 (\$0.083/kWh)
- Qty: 88 luminaires

Fluorescent Replacement

- Floor Size: 72,896 sq ft
- LPD: 0.225 W/sf
 - EAct \$: \$21,868.80
- *Yearly kWh: 143,678 (24/7 Operation)*
- Electricity Cost: \$11,925.88 (\$0.083/kWh)
- LPD: 0.18 W/sf
 - EAct \$: \$45,737.60
- *Yearly kWh: 114,942 (24/7 Operation)*
- Electricity Cost: \$9,540.22 (\$0.083/kWh)
- Qty: 88 luminaires
 - Luminaire Cost: \$250 / per Unit
 - Total Cost: \$22,000
- ROI: < 2 years

Economics

Example

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- LPD: 0.18 W/sf
 - EAct \$: \$45,737.60
- *Yearly kWh: 114,942 (24/7 Operation)*
- Electricity Cost: \$9,540.22 (\$0.083/kWh)
- Qty: 88 luminaires
 - Luminaire Cost: \$750 / per Unit
 - Total Cost: \$66,000
- ROI: < 4 years

Energy Efficiency Parking Garage Program (EEPG)

- Sponsored by Pacific Gas & Electric²
- Incentive
 - \$0.05 / kWh plus pricing discounts.
- Technology:
 - High Performance T8 Fluorescent lighting OR innovative Induction lighting designs. Lighting retrofit will include perimeter daylighting controls to shut off unnecessary lighting during daylight hours.
- Goal:
 - 16 Million kWh and 2,200 kW reduction

Other considerations

- SSL not directly mentioned, but a case could be made for incentive
- Other utility programs could apply: straight \$/kWh or demand response incentives

Controls

- Bi-level operation encouraged based on either occupancy or available daylight
- Microwave-based occupancy sensors switch the luminaire to a low setting when the space (or area near the luminaire) is not occupied
- Daylight sensors to dim the luminaires near the edges of the space open to the daylight



Controls



HID Installation

- Cannot be dimmed easily
- Operating when sufficient daylight exists

Daylight Dimming



Fluorescent Installation

- Can be dimmed easily
- Saves energy when sufficient daylight exists
- Could also be done via LED

Controls



HID Installation

- Cannot toggle between high and low output easily
- Operates at full output all-night

Occupancy Sensing



LED Installation

- Can toggle between high and low output easily
- Saves energy when space is empty
- Could also be done via fluorescent

Case Studies

Case Study

- California Lighting Technology Center³
 - Use of motion sensor saved 30% energy savings compared to HID
- DOE SSL GATEWAY Demonstration⁴
 - Providence Portland Medical Center
 - Saved 60% energy by converting from HPS to LED
 - Payback less than 3 years



Sample Products

WideLite[®]

LightingScience[®]

 **IntellEnergy**
Intelligent Lighting Design Solutions



Lsi
Industries[™]

A Company with a Smart Vision

beta
LED[™]

 **ExcelLine**[®]

 **MetalOptics**[™]
An AcuityBrands Company

NOT AN ENDORSEMENT

Additional Information

References

1. SSL ENERGY STAR

http://www1.eere.energy.gov/buildings/ssl/energy_star.html

2. PG&E-Energy Efficiency Program

<http://www.efm-solutions.com/2.html>

3. Case Study – California Lighting Technology Center

<http://cltc.ucdavis.edu/content/view/354/287/>

4. Case Study – SSL GATEWAY Providence Portland Medical Center

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_ppmc.pdf

Technical Point of Contact

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Additional Information

EPAct 2005

Amended from 5.28.09 Recorded Presentation

During slide 23, The audio says that the EPAct tax credit goes toward *Property Taxes*, but in fact it should be applied to *Income Tax*. Furthermore, the applicable tax bracket is applied to said amount. Therefore, the final EPAct \$ values in slides 24 & 25 for \$21,868.80 (0.225 W/sf) & \$45,737.60 (0.18 W/sf) would be as follows:

Income is between...		Tax Bracket	0.225 W/sf	0.18 W/sf
0	\$8,350	10%	\$2,186.88	\$4,573.76
\$8,350	\$33,950	15%	\$3,280.32	\$6,860.64
\$33,950	\$82,250	25%	\$5,467.20	\$11,434.40
\$82,250	\$171,550	28%	\$6,123.26	\$12,806.53
\$171,550	\$372,950	33%	\$7,216.70	\$15,093.41
\$372,950	Above	35%	\$7,654.08	\$16,008.16

Section 5. Certification Requirements for Interim Lighting Rule

.01 *In General.* Section 2.03(1)(b) of Notice 2006-52 provides an interim rule under which partially qualifying property is treated as energy efficient lighting property (the Interim Lighting Rule). Before a taxpayer may claim the § 179D deduction under the Interim Lighting Rule with respect to energy efficient lighting property installed on or in a commercial building, the taxpayer must obtain a certification with respect to the property. The certification must be provided by a qualified individual. Section 4 of Notice 2006-52 provides that the certification must include a statement that qualified computer software was used to calculate energy and power consumption and costs. That section also provides that the certification must include a statement that the building owner has received an explanation of projected annual energy costs. These requirements are appropriate only in the case of certifications that involve calculations of energy and power consumption and cost. The Interim Lighting Rule is satisfied by a reduction in lighting power density and such a reduction may be computed using a spreadsheet or other similar software. This computation does not require qualified computer software to model the entire building system or a determination of projected annual energy costs. Accordingly, the requirements of section 4 of Notice 2006-52 do not apply to certifications under the Interim Lighting Rule.

Section 5. Certification Requirements for Interim Lighting Rule

.02 Applicable Requirements. A taxpayer is not required to attach the certification to the return on which the deduction is taken. However, § 1.6001-1(a) of the Income Tax Regulations requires that taxpayers maintain such books and records as are sufficient to establish the entitlement to, and amount of, any deduction claimed by the taxpayer. Accordingly, a taxpayer claiming a deduction under § 179D should retain the certification as part of the taxpayer's records for purposes of § 1.6001-1(a) of the Income Tax Regulations. The qualified individual providing a certification under the interim rule must document a reduction in lighting power density in a thorough and consistent manner. A certification under the Interim Lighting Rule will be treated as satisfying the requirements of § 179D(c)(1) if the certification contains all of the following:

- (1) The name, address, and telephone number of the qualified individual;
- (2) The address of the building to which the certification applies;

Section 5. Certification Requirements for Interim Lighting Rule

- (3) A statement by the qualified individual that the interior lighting systems that have been, or are planned to be, incorporated into the building—
- (a) Achieve a reduction in lighting power density of at least 25 percent (50 percent in the case of a warehouse) of the minimum requirements in Table 9.3.1.1 or Table 9.3.1.2 (not including additional interior lighting power allowances) of Standard 90.1-2001;
 - (b) Have controls and circuiting that comply fully with the mandatory and prescriptive requirements of Standard 90.1-2001;
 - (c) Include provision for bi-level switching in all occupancies except hotel and motel guest rooms, store rooms, restrooms, public lobbies, and garages; and
 - (d) Meet the minimum requirements for calculated lighting levels as set forth in the IESNA Lighting Handbook, Performance and Application, Ninth Edition, 2000;

Section 5. Certification Requirements for Interim Lighting Rule

- (4) A statement by the qualified individual that—
 - (a) Field inspections of the building were performed by a qualified individual after the energy efficient lighting property has been placed in service;
 - (b) The field inspections confirmed that the building has met, or will meet, the reduction in lighting power density required by the design plans and specifications; and
 - (c) The field inspections were performed in accordance with inspection and testing procedures that—
 - (i) Have been prescribed by the National Renewable Energy Laboratory (NREL) as Energy Savings Modeling and Inspection Guidelines for Commercial Building Federal Tax Deduction; and
 - (ii) Are in effect at the time the certification is given;

Section 5. Certification Requirements for Interim Lighting Rule

- (5) A list identifying the components of the energy efficient lighting property installed on or in the building, the energy efficiency features of the building, and its projected lighting power density;
- (6) A statement that the building owner has received an explanation of the energy efficiency features of the building and its projected lighting power density;
- (7) A declaration, applicable to the certification and any accompanying documents, signed by the qualified individual, in the following form:

“Under penalties of perjury, I declare that I have examined this certification, including accompanying documents, and to the best of my knowledge and belief, the facts presented in support of this certification are true, correct, and complete.”

Section 6. Application of the Interim Lighting Rule to Unconditioned Garage Space

For purposes of the Interim Lighting Rule, the definition of a Building within the Scope of Standard 90.1-2001 (found in Section 5.01 of Notice 2006-52) is expanded to include a structure -

1. Enclose space affording shelter to persons, animals, or property within exterior walls (or within exterior and party walls) and a roof;
2. Is not a single-family house, a multi-family structure of three stories or fewer above grade, and manufactured house (mobile home), or a manufactured house (modular); and
3. Is unconditioned attached or detached garage space as referenced by Tables 9.3.1.1 and 9.3.1.2 of Standard 90.1-2001